U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-265 585

Sheridan Lake, Pennington County, South Dakota

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Jan 77

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Report on Sheridan Lake, Pennington County, South Dakota	5. REPORT DATE Prepared January 1977
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 624
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED Final - 1974
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES 38
	20. SECURITY CLASS *(This page)*	22. PRICE PC-A03. MFA01

EPA Form 2220-1 (9-73)

PB 265 585

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

P.O. 699-440

REPORT

ON

SHERIDAN LAKE
PENNINGTON COUNTY
SOUTH DAKOTA

EPA REGION VIII

WORKING PAPER No. 624

WITH THE COOPERATION OF THE

SOUTH DAKOTA DEPARTMENT OF ENVIRONMENTAL PROTECTION

AND THE

SOUTH DAKOTA NATIONAL GUARD

JANUARY, 1977

CONTENTS

	Page
Foreward	ii
List of South Dakota Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	8
V. Literature Reviewed	12
VI. Appendices	13

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nation-wide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the South Dakota Departments of Environmental Protection and Game, Fish and Parks for professional involvement, to the South Dakota National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples.

Allyn Lockner, Secretary, and Blaine Barker and Duane Murphy, Department of Environmental Quality; Douglas Hansen, Department of Game, Fish and Parks; and James Hayden, Director, State Lakes Preservation Committee provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

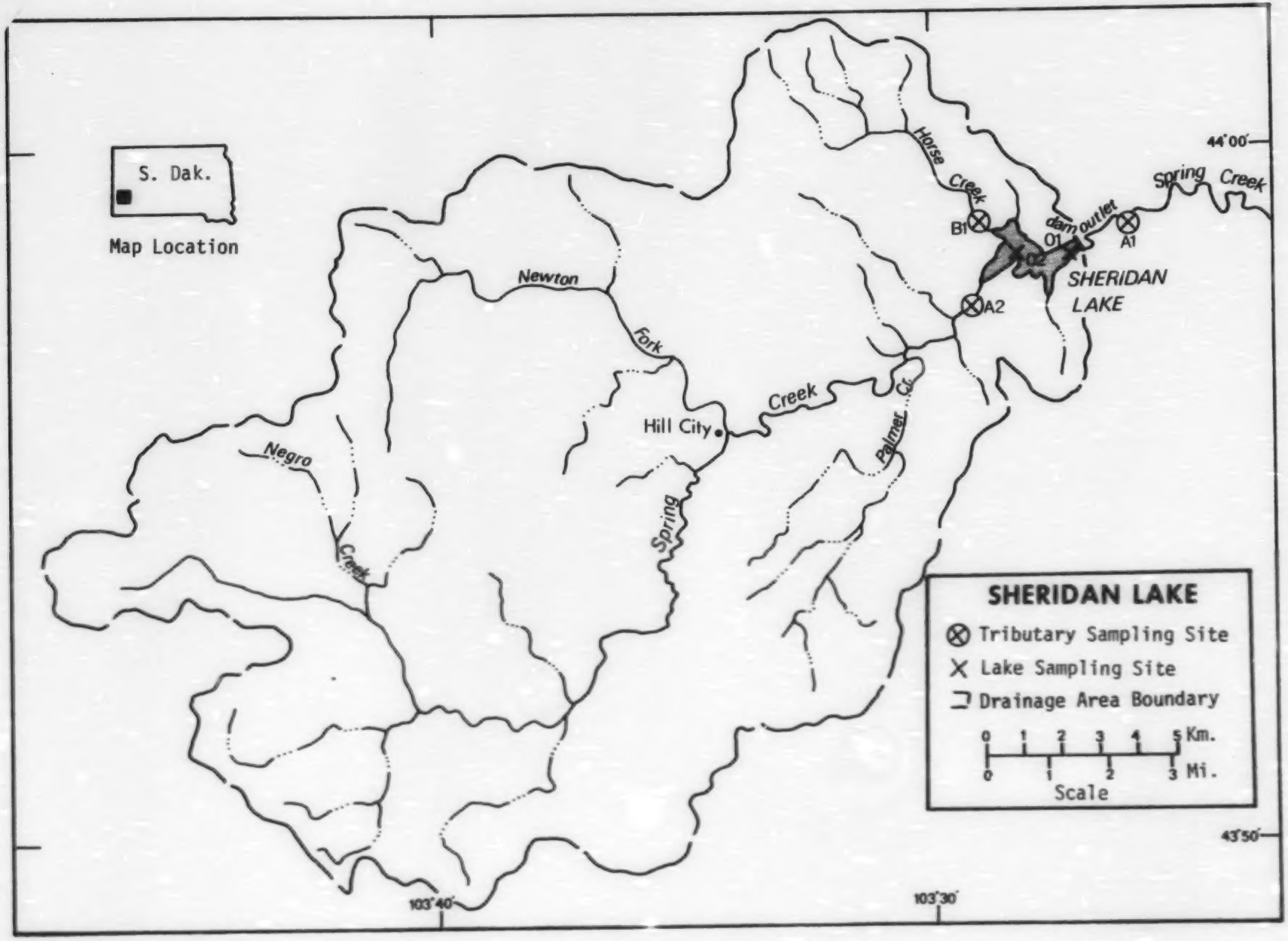
Major General Duane L. Corning, the Adjutant General of South Dakota, and Project Officer Colonel Robert D. Chalberg, who directed the volunteer efforts of the South Dakota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF SOUTH DAKOTA

LAKE NAME	COUNTY
Albert	Kingsbury
Alvin	Lincoln
Angostura	Fall River
Brant	Lake
Byron	Beadle
Clear	Marshall
Clear	Minnehaha
Cochrane	Deuel
Cottonwood	Spink
Deerfield	Pennington
Enemy Swim	Day
Herman	Lake
John	Hamlin
Kampeska	Codington
Madison	Lake
Mitchell	Davidson
Norden	Hamlin
East Oakwood	Brookings
West Oakwood	Brookings
Pactola	Pennington
Pickerel	Day
Poinsett	Brookings, Lake
Red Iron South	Marshall
Richmond	Brown
Roy	Marshall
Sand	Brown
Sheridan	Pennington
Stockdale	Custer
East Vermillion	McCook
Wall	Minnehaha
Waubay	Day


S. Dak.
Map Location
Newton
Fork
Creek
Hill City
Negro
Creek
Spring
Palmer Cr.
Horse Creek
B1
A2
O1
O2
dam outlet
A1
SHERIDAN LAKE
Spring Creek
44°00'
43°50'
103°40'
103°30'
SHERIDAN LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale

SHERIDAN LAKE

STORET NO. 4627

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Sheridan Lake is eutrophic. It ranked ninth in overall trophic quality when the 31 South Dakota lakes sampled in 1974 were compared using a combination of six lake parameters*. Nine of the lakes had less median total phosphorus, ten had less median dissolved orthophosphorus, ten had less and one had the same median inorganic nitrogen, nine had less mean chlorophyll a, and two had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred in July and depletion occurred in September.

Survey limnologists observed submerged aquatic plants and an algal bloom in progress in July.

B. Rate-Limiting Nutrient:

Due to significant changes in orthophosphorus in the samples between the time of collection to the beginning of the algal assays, the results are not representative of conditions in the lake at the time the samples were taken.

The lake data indicate nitrogen limitation all three sampling times.

---

* See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point sources impacted Sheridan Lake during the sampling year. Septic tanks serving lakeshore recreational areas were estimated to have contributed 1.7% of the total phosphorus load, but a shoreline survey would have to be done to determine the significance of those sources.

The present phosphorus loading of 0.19 $g/m^2/yr$ is a little more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (see page 11); however, Survey data indicate that Sheridan Lake is eutrophic. This can be explained by the fact that until recently, the town of Hill City contributed an estimated 465 kg/yr of phosphorus to Sheridan Lake (more than all the present sources combined). In 1973, Hill City eliminated all wastewater discharges by constructing a holding pond system*. If the present phosphorus loading rate is maintained, the trophic quality of Sheridan Lake should improve.

2. Non-point sources--Non-point sources contributed 98.3% of the total phosphorus load to Sheridan Lake during the sampling year. Spring Creek accounted for 74.6%, and the ungaged tributaries contributed an estimated 15.3%.

The phosphorus export rate of Spring Creek was quite low (see page 10) and compates well with French Creek, a tributary of nearby Stockade Lake**.

* Howard, 1976.
** Working Paper No. 625.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 1.56 kilometers^2.
2. Mean depth: 10.2 meters.
3. Maximum depth: 29.3 meters.
4. Volume: 15.912×10^6 m^3.
5. Mean hydraulic retention time: 3.6 years.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Spring Creek	183.9	0.128
Minor tributaries & immediate drainage -	45.0	0.012
Totals	228.9	0.140

2. Outlet -

Spring Creek	230.5**	0.140**

C. Precipitation***:

1. Year of sampling: 43.82 centimeters.
2. Mean annual: 41.73 centimeters.

---

† Table of metric conversions--Appendix B.
†† Murphey, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake; outflow adjusted to equal sum of inflows.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Sheridan Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the April and September visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 23.2 meters at station 1 and 13.1 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SHERIDAN LAKE
STORET CODE 4627

PARAMETER	1ST SAMPLING (4/25/74) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/15/74) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/12/74) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	5.1 - 10.0	7.6	7.4	8.3 - 23.5	16.5	17.0	8.5 - 16.0	13.0	14.3
DISS OXY (MG/L)	8.0 - 10.4	9.4	9.4	0.2 - 9.8	5.3	6.2	0.0 - 8.4	3.2	1.2
CNDCTVY (MCROMO)	155. - 178.	166.	166.	192. - 242.	219.	225.	167. - 185.	175.	175.
PH (STAND UNITS)	****** -**********			7.4 - 9.2	8.3	8.1	7.0 - 8.7	7.7	7.2
TOT ALK (MG/L)	99. - 105.	103.	103.	96. - 121.	108.	109.	84. - 122.	104.	109.
TOT P (MG/L)	0.023 - 0.033	0.027	0.027	0.059 - 0.112	0.071	0.070	0.014 - 0.259	0.076	0.047
ORTHO P (MG/L)	0.003 - 0.008	0.006	0.005	0.040 - 0.085	0.054	0.052	0.004 - 0.084	0.031	0.016
NO2+NO3 (MG/L)	0.030 - 0.060	0.049	0.040	0.020 - 0.100	0.061	0.060	0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.020 - 0.040	0.029	0.030	0.050 - 0.280	0.109	0.065	0.020 - 0.950	0.271	0.180
KJEL N (MG/L)	0.360 - 0.600	0.511	0.500	0.300 - 0.500	0.410	0.400	0.400 - 1.200	0.738	0.700
INORG N (MG/L)	0.050 - 0.100	0.069	0.070	0.090 - 0.330	0.170	0.130	0.040 - 0.970	0.291	0.200
TOTAL N (MG/L)	0.330 - 0.660	0.551	0.540	0.320 - 0.550	0.471	0.470	0.420 - 1.220	0.758	0.720
CHLRPYL A (UG/L)	8.1 - 8.3	8.2	8.2	26.5 - 34.5	30.5	30.5	4.4 - 10.8	7.6	7.6
SECCHI (METERS)	2.6 - 2.7	2.7	2.7	2.7 - 3.2	3.0	3.0	2.4 - 2.4	2.4	2.4

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/25/74	1. *Fragilaria sp.*	1,409
	2. *Cryptomonas sp.*	1,118
	3. *Mesostigma sp.*	895
	4. *Chroomonas sp.*	626
	5. Flagellates	447
	Other genera	1,298
	Total	5,793
07/15/74	1. *Fragilaria sp.*	2,250
	2. *Cryptomonas sp.*	310
	3. *Microcystis sp.*	310
	4. *Anabaena sp.*	116
	5. *Ankistrodesmus sp.*	78
	Other genera	118
	Total	3,182
09/12/74	1. *Aphanizomenon sp.*	632
	2. *Aphanocapsa sp.*	446
	3. *Anabaena sp.*	149
	4. Cyanophytan filaments	149
	5. *Fragilaria sp.*	112
	Other genera	297
	Total	1,785

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
04/25/74	1	8.1
	2	8.3
07/15/74	1	26.5
	2	34.5
09/12/74	1	4.4
	2	10.8

C. Limiting Nutrient Study:

Due to significant changes in orthophosphorus concentrations in the samples between the times of sample collection and the beginning of the assays, the results are not representative of conditions in the lake at the times the samples were taken.

The lake data indicate nitrogen limitation at all three sampling times. The mean inorganic nitrogen to orthophosphorus ratios were 12 to 1 in April, 3 to 1 in July, and 9 to 1 in September, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the South Dakota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of May when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the South Dakota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads at station A-2, in $kg/km^2/year$, and multiplying by the ZZ area in km^2.

No known wastewater treatment plants impacted Sheridan Lake during the sampling year.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

* See Working Paper No. 175.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Spring Creek	220	74.6
b. Minor tributaries & immediate drainage (non-point load) -	45	15.3
c. Known municipal STP's - None	-	-
d. Septic tanks* -	5	1.7
e. Known industrial - None	-	-
f. Direct precipitation** -	25	8.4
Total	295	100.0

2. Outputs -

Lake outlet - Spring Creek 170

3. Net annual P accumulation - 125 kg.

* Estimate based on three campgrounds and a park; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) - Spring Creek	2,715	51.0
b. Minor tributaries & immediate drainage (non-point load) -	675	12.7
c. Known municipal STP's - None	-	-
d. Septic tanks* -	245	4.6
e. Known industrial - None	-	-
f. Direct precipitation** -	1,685	31.7
Total	5,320	100.0

2. Outputs -

Lake outlet - Spring Creek 3,060

3. Net annual N accumulation - 2,260 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Spring Creek	1	15

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Horse Creek	0.023	0.802

* Estimate based on three campgrounds and a park; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.19	0.08	3.4	1.4
Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Sheridan Lake:				
"Dangerous" (eutrophic loading)			0.32	
"Permissible" (oligotrophic loading)			0.16	

V. LITERATURE REVIEWED

Howard, Richard, 1976. Personal communication (wastewater treatment at Hill City). SD Dept. of Env. Prot., Pierre.

Murphey, Duane G., 1974. Personal communication (waterbody information and morphometry). SD Dept. of Env. Prot., Pierre.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Schmidt, Artwin E., 1967. Limnology of selected South Dakota lakes. MS thesis, SD St. U., Brookings.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4601	LAKE ALBERT	0.321	0.170	489.111	106.289	9.200	0.019
4602	ALVIN LAKE	0.067	0.970	442.833	4.700	9.400	0.017
4603	ANGOSTURA RESERVOIR	0.019	0.160	423.333	3.717	13.000	0.005
4604	BRANT LAKE	0.194	0.130	432.833	34.150	11.800	0.113
4605	LAKE BYPON	0.443	0.370	488.333	149.350	9.000	0.146
4606	CLEAR LAKE	0.027	0.075	430.167	11.983	8.800	0.009
4607	CLEAR LAKE	1.400	0.270	495.333	691.000	7.000	0.468
4608	COCHRANE LAKE	0.037	0.150	446.000	15.683	15.000	0.008
4609	COTTONWOOD LAKE	0.685	0.265	490.333	112.017	8.600	0.417
4610	DEERFIELD RESERVOIR	0.033	0.080	303.333	3.650	15.000	0.022
4611	ENEMY SWIM LAKE	0.037	0.085	442.600	14.200	8.200	0.013
4612	LAKE HERMAN	0.340	0.155	485.000	58.733	8.600	0.174
4613	ST JOHN LAKE	0.348	0.080	489.400	120.880	9.800	0.025
4614	LAKE KAMPESKA	0.220	0.105	468.889	20.567	8.200	0.128
4615	MADISON LAKE	0.259	0.090	445.555	22.578	14.000	0.107
4616	LAKE MITCHELL	0.099	0.085	465.833	14.883	13.800	0.015
4617	LAKE NORDEN	0.256	0.165	488.667	46.800	10.000	0.050
4618	OAKWOOD LAKE EAST	0.146	0.175	487.000	113.600	10.000	0.009
4619	OAKWOOD LAKE WEST	0.181	0.135	485.833	159.667	9.600	0.021
4620	PACTOLA RESERVOIR	0.011	0.070	248.444	1.478	11.000	0.006
4621	PICKEREL LAKE	0.049	0.095	439.833	15.833	9.600	0.009
4622	LAKE POINSETT	0.115	0.315	468.444	40.211	10.000	0.023
4623	LAKE RED IRON SOUTH	0.042	0.110	430.333	6.883	7.600	0.010
4624	RICHMOND LAKE	0.187	0.150	410.000	18.467	10.000	0.144
4625	ROY LAKE	0.034	0.070	431.000	13.333	11.000	0.010
4626	SAND LAKE	0.489	0.110	471.800	65.790	12.800	0.288
4627	SHERIDAN LAKE	0.053	0.105	394.000	15.433	15.000	0.016
4628	STOCKADE LAKE	0.233	0.150	432.000	25.400	15.000	0.109

DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4629	LAKE VERMILLION	0.211	0.100	472.833	100.800	9.200	0.092
4630	WALL LAKE	0.194	0.160	441.667	55.267	7.400	0.076
4631	WAUBAY LAKE NORTH	0.098	0.145	469.555	127.033	11.400	0.023

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4601	LAKE ALBERT	20 (6)	20 (6)	10 (3)	23 (7)	68 (20)	60 (18)	201
4602	ALVIN LAKE	67 (20)	0 (0)	57 (17)	90 (27)	63 (19)	63 (19)	340
4603	ANGOSTURA RESERVOIR	97 (29)	30 (9)	87 (26)	93 (28)	20 (6)	100 (30)	427
4604	BRANT LAKE	40 (12)	53 (16)	70 (21)	47 (14)	27 (8)	23 (7)	260
4605	LAKE BYRON	10 (3)	3 (1)	17 (5)	7 (2)	73 (22)	13 (4)	123
4606	CLEAR LAKE	93 (28)	93 (28)	83 (25)	83 (25)	77 (23)	90 (27)	519
4607	CLEAR LAKE	0 (0)	10 (3)	0 (0)	0 (0)	100 (30)	0 (0)	110
4608	COCHRANE LAKE	83 (25)	40 (11)	50 (15)	67 (20)	5 (0)	93 (28)	338
4609	COTTONWOOD LAKE	3 (1)	13 (4)	3 (1)	20 (6)	82 (24)	3 (1)	124
4610	DEERFIELD RESERVOIR	90 (27)	88 (26)	97 (29)	97 (29)	5 (0)	53 (16)	430
4611	ENEMY SWIM LAKE	80 (24)	82 (24)	60 (18)	77 (23)	88 (26)	73 (22)	460
4612	LAKE HERMAN	17 (5)	33 (10)	27 (8)	33 (10)	82 (24)	10 (3)	202
4613	ST JOHN LAKE	13 (4)	88 (26)	7 (2)	13 (4)	53 (16)	43 (13)	217
4614	LAKE KAMPESKA	33 (10)	65 (19)	40 (12)	57 (17)	88 (26)	20 (6)	303
4615	MADISON LAKE	27 (8)	77 (23)	53 (16)	53 (16)	13 (4)	30 (9)	253
4616	LAKE MITCHELL	60 (18)	82 (24)	47 (14)	73 (22)	17 (5)	70 (21)	349
4617	LAKE NORDEN	23 (7)	23 (7)	13 (4)	40 (12)	45 (12)	40 (12)	184
4618	OAKWOOD LAKE EAST	53 (16)	17 (5)	20 (6)	17 (5)	45 (12)	85 (25)	237
4619	OAKWOOD LAKE WEST	50 (15)	50 (15)	23 (7)	3 (1)	58 (17)	57 (17)	241
4620	PACTOLA RESERVOIR	100 (30)	98 (29)	100 (30)	100 (30)	35 (10)	97 (29)	530
4621	PICKEREL LAKE	73 (22)	73 (22)	67 (20)	63 (19)	58 (17)	85 (25)	419
4622	LAKE POINSETT	57 (17)	7 (2)	43 (13)	43 (13)	45 (12)	47 (14)	242
4623	LAKE RED IRON SOUTH	77 (23)	58 (17)	80 (24)	87 (26)	93 (28)	78 (23)	473
4624	RICHMOND LAKE	47 (14)	40 (11)	90 (27)	60 (18)	45 (12)	17 (5)	299
4625	ROY LAKE	87 (26)	98 (29)	77 (23)	80 (24)	35 (10)	78 (23)	455
4626	SAND LAKE	7 (2)	58 (17)	33 (10)	30 (9)	23 (7)	7 (2)	158
4627	SHERIDAN LAKE	70 (21)	65 (19)	93 (26)	70 (21)	5 (0)	67 (20)	370
4628	STOCKADE LAKE	30 (9)	40 (11)	73 (22)	50 (15)	5 (0)	27 (8)	225

CENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4629	LAKE VERMILLION	37 (11)	70 (21)	30 (9)	27 (8)	68 (20)	33 (10)	265
4630	WALL LAKE	43 (13)	27 (8)	63 (19)	37 (11)	97 (29)	37 (11)	304
4631	WAUBAY LAKE NORTH	63 (19)	47 (14)	37 (11)	10 (3)	30 (9)	50 (15)	237

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4620	PACTOLA RESERVOIR	530
2	4606	CLEAR LAKE	519
3	4623	LAKE RED IRON SOUTH	473
4	4611	ENEMY SWIM LAKE	460
5	4625	ROY LAKE	455
6	4610	DEERFIELD RESERVOIR	430
7	4603	ANGOSTURA RESERVOIR	427
8	4621	PICKEREL LAKE	419
9	4627	SHERIDAN LAKE	370
10	4616	LAKE MITCHELL	349
11	4602	ALVIN LAKE	340
12	4608	COCHRANE LAKE	338
13	4630	WALL LAKE	304
14	4614	LAKE KAMPESKA	303
15	4624	RICHMOND LAKE	299
16	4629	LAKE VERMILLION	265
17	4604	BRANT LAKE	260
18	4615	MADISON LAKE	253
19	4622	LAKE POINSETT	242
20	4619	OAKWOOD LAKE WEST	241
21	4631	WAUBAY LAKE NORTH	237
22	4618	OAKWOOD LAKE EAST	237
23	4628	STOCKADE LAKE	225
24	4613	ST JOHN LAKE	217
25	4612	LAKE HERMAN	202
26	4601	LAKE ALBERT	201
-	4617	LAKE NORDEN	184
	426	SAND LAKE	158

KES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	4609	COTTONWOOD LAKE	124
30	4605	LAKE BYRON	123
31	4607	CLEAR LAKE	110

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR SOUTH DAKOTA 05/03/76

LAKE CODE 4627 SHERIDAN

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 230.5

NORMALIZED FLOWS(CMS)

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4627A1	230.5	0.085	0.085	0.085	0.170	0.227	0.340	0.227	0.170	0.085	0.085	0.085	0.085	0.144
4627A2	183.9	0.085	0.085	0.085	0.142	0.170	0.283	0.198	0.142	0.085	0.085	0.085	0.085	0.128
4627ZZ	46.6	0.0	0.0	0.0	0.028	0.028	0.057	0.028	0.0	0.0	0.0	0.0	0.0	0.012

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 230.5
SUM OF SUB-DRAINAGE AREAS = 230.5

TOTAL FLOW IN = 1.67
TOTAL FLOW OUT = 1.73

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4627A1	10	74	0.057	12	0.057				
	11	74	0.057	16	0.057				
	12	74	0.028	14	0.028				
	1	75	0.028	14	0.028				
	2	75	0.028	15	0.028				
	3	75	0.085	8	0.057				
	4	75	0.227	12	0.283				
	5	75	0.085	10	0.142				
	6	75	0.085	14	0.085				
	7	75	0.085	5	0.085				
	8	75	0.057	21	0.057				
	9	75	0.057	13	0.057				
4627A2	10	74	0.057	12	0.057				
	11	74	0.057	16	0.057				
	12	74	0.028	14	0.028				
	1	75	0.028	14	0.028				
	2	75	0.028	15	0.028				
	3	75	0.085	8	0.028				
	4	75	0.227	12	0.283				
	5	75	0.142	10	0.170				
	6	75	0.085	14	0.113				
	7	75	0.057	5	0.057				
	8	75	0.057	21	0.057				
	9	75	0.057	13	0.057				
4627ZZ	10	74	0.028						
	11	74	0.028						
	12	74	0.028						
	1	75	0.014						
	2	75	0.014						
	3	75	0.014						
	4	75	0.057						
	5	75	0.057						
	6	75	0.028						
	7	75	0.028						
	8	75	0.028						
	9	75	0.028						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/05/03

462701
43 58 31.0 103 27 06.0 3
SHERIDAN LAKE
46103 SOUTH DAKOTA

090491

11EPALES 2111202
0080 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/25	13 00	0000	8.8			170		105	0.030	0.600	0.040	0.005
	13 00	0005	8.7	10.2	108	170		104	0.030	0.500	0.040	0.007
	13 00	0020	6.3	9.4		161		102	0.030	0.500	0.050	0.005
	13 00	0045	5.9	9.0		158		104	0.040	0.600	0.060	0.005
	13 00	0070	5.1	8.0		155		104	0.040	0.500	0.030	0.003
74/07/15	15 05	0000	23.5	9.6	108	242	9.00	100	0.050	0.500	0.050	0.043
	15 05	0005	23.5	9.8		240	9.00	99	0.050	0.400	0.060	0.052
	15 05	0020	15.8	5.6		222	7.90	115	0.070	0.400	0.070	0.040
	15 05	0040	9.1	0.8		192	7.60	113	0.140	0.400	0.100	0.046
	15 05	0060	8.3	0.6		192	7.40	121	0.280	0.500	0.050	0.057
74/09/12	14 10	0000	16.0	8.4	96	169	8.61	88	0.040	0.700	0.020K	0.009
	14 10	0005	16.0	7.6		167	8.67	86	0.030	0.600	0.020K	0.014
	14 10	0020	15.4	5.4		175	8.21	89	0.060	0.600	0.020K	0.016
	14 10	0025	14.3	1.2		179	7.21	107	0.180	0.700	0.020K	0.035
	14 10	0030	12.3	0.0		185	7.01	110	0.280	0.800	0.020K	0.051
	14 10	0050	9.0	0.0		171	7.03	115	0.700	1.100	0.020K	0.041
	14 10	0076	8.5	0.0		175	7.01	119	0.950	1.200	0.020K	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCOT LT REMNING PERCENT
74/04/25	13 00	0000	0.027	8.1	
	13 00	0005	0.028		
	13 00	0020	0.023		
	13 00	0045	0.024		1.0
	13 00	0070	0.024		
74/07/15	15 05	0000	0.059	26.5	
	15 05	0005	0.060		
	15 05	0020	0.059		
	15 05	0040	0.072		1.0
	15 05	0060	0.072		
74/09/12	14 10	0000	0.027	4.4	
	14 10	0005	0.028		
	14 10	0020	0.029		
	14 10	0025	0.047		
	14 10	0030	0.074		
	14 10	0050	0.098		
	14 10	0076	0.259		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/05/03

462702
43 58 23.0 103 28 15.0 3
SHERIDAN LAKE
46103 SOUTH DAKOTA

090491

11EPALES 2111202
0041 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO26NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/25	13 35	0000	10.0		102	178		103	0.020	0.600	0.040	0.008
	13 35	0005	10.0	10.2		176		102	0.020	0.500	0.030	0.007
	13 35	0020	7.4	10.4		166		103	0.030	0.500	0.040	0.006
	13 35	0035	5.9	8.8		160		99	0.020	0.300	0.030	0.004
74/07/15	14 40	0000	23.5	9.6	126	238	9.20	101	0.060	0.400	0.080	0.056
	14 40	0005	23.4	9.6		239	9.10	98	0.050	0.400	0.070	
	14 40	0017	18.2	6.8		227	8.40	105	0.050	0.400	0.060	0.047
	14 40	0030	10.4	0.2		203	7.60	112	0.070	0.300	0.020	0.056
	14 40	0041	9.2	0.2		198	7.40	118	0.270	0.400	0.050	0.085
74/09/12	14 35	0000	16.0	8.0	96	175	8.65	109	0.020	0.400	0.020K	0.006
	14 35	0005	15.9	7.8		167	8.63	84	0.030	0.600	0.020	0.013
	14 35	0025	15.2	3.6		177	7.69	93	0.100	0.500	0.020K	0.013
	14 35	0030	11.5	0.2		183	7.03	112	0.290	0.700	0.020K	0.054
	14 35	0035	9.8	0.0		179	7.03	117	0.620	0.500	0.020K	0.063
	14 35	0043	9.1	0.0		175	7.03	122	0.220	1.200	0.020K	0.084

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/25	13 35	0000	0.028	8.3	
	13 35	0005	0.030		
	13 35	0020	0.027		1.0
	13 35	0035	0.033		
74/07/15	14 40	0000	0.072	34.5	
	14 40	0005	0.064		
	14 40	0017	0.068		1.0
	14 40	0030	0.076		
	14 40	0041	0.112		
74/09/12	14 35	0000	0.014	10.8	
	14 35	0005	0.029		
	14 35	0025	0.026		
	14 35	0030	0.081		
	14 35	0035	0.132		
	14 35	0043	0.148		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/05/04

4627A1
43 28 55.0 103 25 55.0 4
SPRING CREEK
46103 7.5 MT RUSHMORE
U/SHERIDAN LAKE 090491
SEC RD BRDG 1 MI NE OF SHERIDAN LAKE DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/12	14 25		0.008	0.400	0.015	0.020	0.030
74/11/16	09 00		0.032	0.300	0.025	0.015	0.025
75/03/08	12 00		0.376	1.000	0.072	0.012	0.030
75/04/12	12 00		0.070	0.900	0.130	0.020	0.080
75/05/10	16 20		0.015	0.650	0.020	0.010	0.020
75/05/22	13 15		0.005	1.900	0.020	0.015	0.085
75/06/14	14 00		0.015	0.575	0.020	0.010	0.035
75/07/05	07 00		0.055	0.350	0.035	0.035	0.045
75/08/21	17 15		0.015	0.500	0.015	0.025	0.047

ORET RETRIEVAL DATE 76/05/04

4627A2
43 57 35.0 103 29 35.0 4
SPRING CREEK
6103 7.5 MT RUSHMORE
T/SHERIDAN LAKE 090491
UNIMPROVED RD XING JUST OFF US HWY 385
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/12	15	00	0.008	0.200	0.010	0.010	0.020
74/11/16	09	30	0.176	0.100	0.010	0.015	0.020
74/12/14	12	00	0.256	0.300	0.020	0.010	0.010
75/03/08	12	20	0.368	1.050	0.080	0.032	0.050
75/04/12	12	30	0.240	1.450	0.080	0.035	0.080
75/05/10	11	54	0.015	0.550	0.042	0.015	0.030
75/06/14	12	20	0.020	0.400	0.030	0.025	0.060
75/07/05	07	20	0.020	0.300	0.020	0.040	0.050
75/08/21	07	45	0.020	0.950	0.020	0.040	0.080
75/09/13	13	00	0.020	0.300	0.010	0.005K	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/05/04

462781
43 59 05.0 103 29 10.0 4
MORSE CREEK
46103 7.5 MT RUSHMORE
T/SHERIDAN LAKE 090491
SEC RD BRDG .8 MI NW OF SHERIDAN LAKE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/12	14 45		0.024	1.600	0.025	0.010	0.020
74/11/16	09 20		0.152	0.400	0.015	0.010	0.010
74/12/14	11 45		0.192	0.200	0.015	0.015	0.020
75/02/15	10 35		0.216	1.200	0.016	0.016	0.020
75/03/08	12 11		0.144	0.650	0.024	0.008	0.010
75/04/12	12 15		0.195	1.700	0.120	0.025	0.050
75/05/10	11 41		0.040	0.450	0.015	0.010	0.010
75/06/14	14 10		0.020	0.300	0.025	0.010	0.020
75/07/05	07 10		0.020	0.300	0.010	0.010	0.020
75/08/21	07 30		0.020		0.045	0.015	0.040
75/09/13	12 50		0.020	0.200	0.005	0.005K	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED